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from Carboniferous, and we have yet to obtain a much fuller knowledge than we now possess of the Devonian fossils of Keewatin and the area to the southwest of James Bay.

J. F. WHITEAVES.

OTTAWA, June 28, 1899.

#### SECTION B—PHYSICS.

THE work of this section at the Columbus meeting was extremely gratifying to those who were fortunate enough to attend; although no papers of an epoch making nature were presented, still all those which were read were of a good character, and seemed to represent a large part of the work in physics in this country, for the past year or more. Several of the papers were of considerable importance, and it is hoped that they will find their way into the columns of this JOURNAL before long.

The meetings of the section were well attended and the discussions were intelligent, interesting and to the point. It should be a matter of congratulation that the Association succeeded in collecting at Columbus so large a number of working physicists and presented such a good series of papers. It seems that more and more such scientists and such papers as are found at the meetings of the British Association are coming to these meetings.

The address of the Vice-President, Dr. Elihu Thomson, 'On the Field of Experimental Research,' was published in SCIENCE for August 25th.

Professor Caldwell presented a number of interesting diagrams, which by appropriate super-position enable one to point out the constants of current and electromotive force in the rotary converter. These diagrams must be extremely useful in presenting the complex question of the operation of these machines.

Professor Eddy showed a simple and convenient method for constructing the entropy-temperature diagrams of a gas or oil

engine from the indicator card; and showed how these diagrams enable one to readily detect the advantages or defects in the running of such engines.

Mr. Briggs' new variable condenser consists of a series of alternating plates of mica and spring brass. The capacity is increased by compressing the plates together by means of a thumb-screw.

In photometric operations we are accustomed to compare the relative illumination of two surfaces by looking at them, and guessing at their relative intensity, or by endeavoring to make the illumination of the two surfaces equal. In Professor Cattell's method, however, the difference between the two surfaces is measured by the time it requires for the observer to decide which of the two surfaces is the brighter; it being a fair assumption that the difference in the impressions is a function of the time required to distinguish between them. A considerable series of observations have confirmed the belief that this method is not only applicable but highly advantageous.

In Professor Cattell's other paper, he brought before the section an extremely interesting and novel observation, which must throw considerable light upon the relative importance of the retina and the brain in the operation of vision. He finds that if, by a motion of the eye, the images of black and white bars are made to pass over the retina at the rate of even a hundred or a thousand per second, still the eye or the brain perceives them as individual bars, and not as a fused gray surface; of course, when the eye is stationary, if light and dark images are caused to pass over the retina at a much less rate, we have perfect fusion. Thus it seems a matter of vital importance in distinct vision, when the image moves on the retina, whether the eye is moving and the object stationary, or the reverse. These experiments indicate that the phenomena of vision are chiefly cerebral

and not chiefly retinal, and that our operation of vision has been developed by evolution to that which is necessary for convenience and self-preservation.

The two papers by Mr. Wead were of special interest from the historical point of view, presenting on the one hand, with considerable elaboration, the development of the organ pipe as seen in the various instructions as to their manufacture, length and other dimensions; incidentally the perfection of the organ pipe at any particular era, of course, enables us to judge to some extent as to the musical conditions existing at that time. In the study of the literature of the musical scale, much interesting information has been obtained with reference to the so-called Arab scale, extant descriptions of certain Arab musical instruments, such as the lute, the tambour of Bagdad and others, enable us to see the way in which the musical scale was built up, and how, in many cases, the interpolation of a note in the scale was determined, not by conditions of harmony, but by the dimensions of the neck and the location of frets upon the instrument in use.

A thoroughly new phenomenon in connection with the effect of an alternating current of electricity upon the human system was presented by Dr. Scripture. He has found that when the alternations in a current of electricity become as frequent as 5,000 per second, the nerves of the part affected cease to react to pain, that is, a high frequency alternating current, instead of producing the muscular contraction brought about by lower frequency, produces a local anesthesia or rather analgesia; the current should be sinusoidal with equal positive and negative phases. Experiments have been tried in sending the current along the superior maxillary nerve with a view of cutting off the teeth from connection with the brain; as yet, however, the frequency has not been high enough to ob-

viate contraction of the facial muscles. It would appear that in this phenomenon we have a very valuable contribution to the methods of surgery.

Messrs. Carhart and Guthe have continued their absolute determination of electrical units, and now offer the value 1.4333 volts at 15° C. as the electromotive force of the standard Clark Cell.

In Mr. Trowbridge's paper on the coherer, we have a praiseworthy endeavor to present quantitative results, instead of haphazard observations upon this instrument which has recently become so important. Using a coherer consisting of 22 hard steel balls in a glass tube, he was able to discover the conditions of current and pressure necessary for the operation of a coherer; he found, for example, that a minimum electromotor force of from 8 to 10 volts is necessary to break down the resistance of the coherer, but that after the resistance had been broken, subsequent discharges do not reduce the resistance much further; it thus would appear that it is the first rush of the electricity through the coherer which produces the result, and that subsequent discharges are without useful effect; that is, an oscillatory discharge is not necessary, a single impulse is sufficient. This observation explains much of the confusion that has puzzled workers in wireless telegraphy.

In No. 12 and No. 16 were presented observations and conclusions with reference to the complex operations that take place in an electrolytic cell. The relations between polarization, capacity and resistance being an extremely puzzling question.

In No. 13 was presented the fact that a magnetic field surrounding an alternating current arc tends to flatten the top of the electric wave and to increase the efficiency. A similar effect is produced by an aluminum electrolytic cell where the formation of a film of oxide acts like the dielectric of a condenser, and reverses the phrase.

In No. 15 the difficulty of determining permeability and hysteresis is pointed out, and it is shown that the pull in the permeater should be represented by

$$S(B^2 - B \cdot H)/8\pi \text{ instead of } S(B^2 - H^2)/8\pi.$$

Mr. Wolff told the section of the present condition of the office of standard weights and measures at Washington, and the progress that has been made toward the equipment of the laboratory for the verification of electrical apparatus. It is gratifying to know that even now we have a trustworthy bureau to which electrical standards may be sent for testing.

He also presented some experiments as to whether current density affects resistance, that is as to the universal truth of Ohm's law. If the resistance is expressed as a function of current density in the following form :

$$R_c = R_0 \left\{ 1 + h \left( \frac{c}{s} \right)^2 \right\}, \quad \frac{c}{s} \text{ is current den-}$$

sity, then  $h$  cannot be greater than  $1/600,000,000$ .

In No. 20 were presented some extremely interesting and important generalizations with reference to the effect of broad areas of atmospheric pressure upon the weather. This paper will appear in *The American Journal of Science*.

Mr. Brace in No. 21 and No. 22 presented some interesting optical matter whose appearance in detail in the journals will be awaited with interest.

Certainly one of the most important papers presented was No. 23, in which Mr. Fessenden presented a large mass of theoretical and experimental material tending to give a clue as to the nature of electricity and magnetism, and also to give a value for the elasticity and density of the ether. He pointed out the great advantage of discussing physical problems by means of dimensional formulæ, showing that these were particularly valuable in pointing out

the direction in which the investigation should tend, and in checking the results of more elaborate mathematical analysis. A detailed abstract of this paper is not embodied here, because it is believed that it will appear in *SCIENCE* before long.

Everyone is now interested in the question of smokeless powder, and the freedom from observation which it gives to the soldier. It is interesting to see in this connection from No. 25, that Mr. Fessenden has discovered a very simple and apparently effective means of locating the flash from smokeless powder, by simply providing the observer with a piece of pale red glass, it having been found that these flashes are strong in red light, whereas the general landscape is very weak in red.

In No. 28 Mr. Fessenden raised the question as to whether it is necessary to suppose that the conditions of terrestrial radiation have always been similar to those which exist at present; in other words, as to whether Lord Kelvin's estimate for the age of the earth which has been declared entirely inadequate by biologists, may not have to be extended, owing to an earlier excessive rate of radiation, due to the absence of a blanketing atmosphere.

No. 29 and No. 30 are valuable contributions to the subject of the wave-length of energy radiated from 'black' bodies at various temperatures.

In No. 32 Mr. Cook has made some interesting computations as to the conditions of time and temperature necessary for a planet to lose an atmosphere consisting of gases, ranging in density from carbonic acid gas to hydrogen.

No. 36 gives a continuation of Mr. Gray's interesting investigation upon the dielectric strength of oils. He finds, for example, that the strength per cm. decreases as the layer increases in thickness.

In No. 37 he has called attention to an error in a new Watt-meter, caused by the

resistance coils absorbing moisture from the atmosphere, and also to the effects of capacity around the fine wire coil of a Watt-meter.

The full program was as follows :

1. Apparatus for the demonstration of the varying currents in the different conductors of a rotary converter. F. C. Caldwell, Columbus, O.
2. A new graphical method of constructing the entropy-temperature diagram from the indicator card of a gas or oil engine. H. T. Eddy, Minneapolis, Minn. *Trans. Am. Soc. Mech. Eng.*
3. Compound harmonic vibration of a string. W. Hallock, New York, N. Y. *SCIENCE*.
4. A new form of electrical condenser, having a capacity capable of continuous adjustment. Lyman J. Briggs, Washington, D. C.
5. Relations of time and space in vision. J. McK. Cattell, New York, N. Y. *Psychological Review*.
6. Time of perception as a measure of the intensity of light. J. McK. Cattell, New York, N. Y. *Psychological Review*.
7. The musical scales of the Arabs. Charles K. Wead, Washington, D. C.
8. Medieval organ pipes and their bearing on the history of the scale. Charles K. Wead, Washington, D. C. 'Music,' Chicago.
9. Electrical anesthesia. E. W. Scripture, New Haven, Conn.
10. An absolute determination of the E.M.F. of a Clark cell. H. S. Carhart and K. E. Guthe, Ann Arbor, Mich. *Physical Review*.
11. Quantitative investigation of the coherer. Augustus Trowbridge, New Haven, Conn. *Am. Jour. Sci.*, Sept., 1899.
12. Polarization and polarization capacity of an electrolytic cell. K. E. Guthe and M. D. Atkins, Ann Arbor, Mich. *Physical Review*.
13. Current and voltage curves in the magnetically blown arc and in the aluminum electrolytic cell. Reginald A. Fessenden, Allegheny, Pa.
14. Some new apparatus — tachometer, chronograph, data collector, induction coil, balance for standardizing amperemeters, standard of induction. Reginald A. Fessenden, Allegheny, Pa.
15. Measurement of magnetism in iron and the relation between permeability and hysteresis. Reginald A. Fessenden, Allegheny, Pa.
16. Polarization and internal resistance of the copper voltameter. B. E. Moore, Lincoln, Nebr. *Physical Review*.
17. Concerning the fall of potential at the anode in a Geissler tube. C. A. Skinner, Lincoln, Nebr. *Wiedemann Annalen*.
18. The equipment and facilities of the Office of U. S. Standard Weights and Measures for the verification of electrical standard and measuring apparatus. F. A. Wolff, Jr., Washington, D. C.
19. An experimental test of the accuracy of Ohm's law. F. A. Wolff, Jr., Washington, D. C.
20. March weather in the United States. O. L. Fassig, Baltimore, Md. *Am. Jour. Sci.*
21. A new spectrophotometer and a method of optically calibrating the slit. D. B. Brace, Lincoln, Nebr.
22. On achromatic polarization in crystalline combinations. D. B. Brace, Lincoln, Nebr.
23. On the nature of electricity and magnetism and a determination of the density and elasticity of the ether. Reginald A. Fessenden, Allegheny, Pa. *SCIENCE*. Read in joint session with Section A.
24. Advances in theoretical meteorology. Cleveland Abbe, Washington D. C. Read by title.
25. Location of smokeless powder discharge by means of colored screens. Reginald A. Fessenden, Allegheny, Pa.
26. A method for the study of phosphorescent sulphides. Fred E. Kester, Columbus, O. *Physical Review*.
27. Accidental double refraction in colloids and crystalloids, B. V. Hill, Lincoln, Nebr. *Philosophical Magazine*.
28. Note on the age of the earth. Reginald A. Fessenden, Allegheny, Pa.
29. A bolometric study of the radiations of a black body between 600° C. and 1100° C. C. E. Mendenhall, Williamstown, Mass. *Astrophysical Journal*.
30. A bolometric study of the radiations of an absolute black body. F. A. Saunders, Haverford, Pa. *Astrophysical Journal*.
31. On thermodynamic surfaces of pressure-volume-temperature for solid, liquid and gaseous state. F. E. Nipher, St. Louis, Mo. *Trans. St. Louis Acad. Sci.* Read by title.
32. On the escape of gases from the planets according to the kinetic theory. S. R. Cook, Lincoln, Nebr. *Astrophysical Journal*.
33. On differential dispersion in double refracting media. E. J. Rendtorff, Lincoln, Nebr.
34. Relation of magnetization to the modulus of elasticity. J. S. Stevens, Orono, Me. *Physical Review*.
35. On flutings in the Kundt sound tube. S. R. Cook, Lincoln, Nebr. *Philosophical Magazine*.
36. Dielectric strength of oils. Thomas Gray, Terre Haute, Ind.
37. Some unexpected errors in watt-meter measurements. Terre Haute, Ind.
38. Note on the preparation of reticles. David P. Todd, Amherst, Mass. Read by title.

39. The nature of spoken vowels, with reference to the theories of Helmholtz and Hermann. E. W. Scripture, New Haven, Conn. Read by title.

40. Pressure and wave-length. J. F. Mohler, Carlisle, Pa. Read by title. *Astrophysical Journal*.

41. The attenuation of sound and the constant of radiation of air. A. Wilmer Duff, Ithaca, N. Y. Read by title. *Physical Review*.

42. Optical calibration of the slit of a spectrometer. E. V. Capps, Lincoln, Nebr.

WILLIAM HALLOCK,  
Secretary.

COLUMBIA UNIVERSITY.

#### SECTION I.—SOCIAL AND ECONOMIC SCIENCE.

SEVENTEEN papers were announced, fourteen of which were given in full and three were read by title. The address of the Vice-President, Dr. Marcus Benjamin, will be published in a subsequent number of SCIENCE.

There were four morning sessions and two afternoon sessions, and the interest was sustained till 3:30 on the last day.

The first paper was by Mr. John Hyde, of the U. S. Department of Agriculture, on 'The Relation of Indian Corn to the Wheat Problem.' Mr. Hyde traced the development of corn raising and wheat raising from their beginnings, showing that wheat had passed a maximum while corn was apparently approaching one. Though quite independent in production, the sympathetic agreement in price is remarkable. Mr. Hyde predicted a permanent foothold and an increasing demand for American corn. While the United States is admirably fitted for corn the same is true of relatively few other lands. Wheat may be sown either in the spring or fall, and in many lands. We cannot expect to control the wheat market, but we can the corn.

Miss Cora A. Benneson, a lawyer of high standing on Federal matters, gave a paper on 'Federal Guarantees for Maintaining Republican Government in the States,' in which she pointed out that the constitution guaranteed to every State in the Union a

republican government without defining what this is. This power has been used in regard to disputed possession of territory, to suppress riots, etc., and the reconstruction following the Civil War, federal intervention was constantly needed, even beyond those warranted by the constitution. It is a question how far the provision of the constitution guarantees a republican form of government to territories, it depending on what is included under 'United States.'

Mr. Henry Farquhar, of the U. S. Department of Agriculture, gave a short paper on 'Calculations of population in June, 1900.' The formula employed by Mr. Farquhar was

$$\Delta p = \frac{p}{e + fp + gp^2}$$

in which  $p$  is the population shown by a United States Census.  $\Delta p$  is the 'natural increase' in a decade, excluding immigration;  $e, f, g$  are constants determined from former United States Censuses, after deducting immigration figures. In all his calculations Mr. Farquhar rejected the Census of 1870 as defective. The immigration for the decade ending next June he put at 3,750,000. Expressing  $p$  in millions, and calculating the constants from different sets of data, the writer produced four separate calculations of the population, as thus shown:

	$e$	$f$	$g$	$p$ in 1900
<i>A</i>	2.862	0.035	0.00091	73,648,000
<i>B</i>	2.279	0.086	0.	74,693,000
<i>C</i>	2.570	0.073	0.	75,679,000
<i>D</i>	3.350	0.000	0.0012	74,466,000

The writer preferred *C* over the others, and concluded that the next Census would show more than 75,000,000 and less than 76,000,000.

Mrs. Florence Kelley, the Corresponding Secretary of the National Consumers' League, read a thirty minute paper on